TOBACCO SMOKE CONSTITUENTS:
EXECUTIVE SUMMARY

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I

Tobacco smoke has been the subject of intensive research over many years, in an effort to identify the constituents of smoke and to determine what effect, if any, smoking may have on humans. By some estimates, over 4,000 constituents of cigarette smoke have been identified thus far, and such research is continuing. No constituent as found in cigarette smoke, however, has been scientifically proven to cause cancer or any other human disease.[1]

II

Ninety percent of cigarette smoke is air, water and carbon dioxide, a natural by-product of combustion. Of the remaining 10 percent, only a few substances such as nicotine and carbon monoxide (CO) are detectable at levels above one milligram per cigarette. The vast majority of the remaining compounds in cigarette smoke are present only in extremely small amounts, measured in micrograms (millionths of a gram) or nanograms (billionths of a gram) per cigarette. Although under experimental conditions, involving laboratory animals, some substances in cigarette smoke may have a toxic or disease-inducing effect, the concentrations at which a smoker is exposed to these same substances have not been demonstrated to cause disease in humans.

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III

"Tar" is frequently the subject of public comment and criticism by anti-smoking advocates as causing cancer in smokers. "Tar" is an artificially created laboratory product consisting of highly concentrated and physically altered cigarette smoke particulate matter which is collected either by passing cigarette smoke through a cold trap at extremely low temperatures or by using filters and a drying process. That may be why this product is sometimes referred to as condensate. No human smoker is exposed to "tar" in the form that it is used for experimentation in the laboratory.

Nevertheless, such "tar" has been the subject of animal experiments to investigate the possible relationship between tobacco smoke and cancer. In those experiments, "tar" was repeatedly painted on the shaved backs or ears of test animals over prolonged periods of time. Some of these tests resulted in the production of tumors. These test results, however, should not and cannot be extrapolated to the human smoker. The differences in the method of exposure between skin painting experiments and smoking are obvious. Likewise the concentrations of "tar" used in such experiments are extremely high. Consequently, such experiments have been said to involve applying "the wrong material in the wrong form, in the wrong dosage, to the wrong tissue of the wrong animal."[2]

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IV

Nicotine is present in cigarette smoke because it is a natural element of tobacco. Anti-smoking advocates often blame nicotine for the development of heart disease. Yet no biological mechanism by which nicotine, or any other agent, may be involved in heart disease has been demonstrated. Moreover, no correlation between the nicotine level of the cigarette or the number of cigarettes smoked and the smoker's actual nicotine intake has been established because of individual variations of puff rates, depth of inhalation, and body metabolism.[3]

V

CO is produced by burning cigarettes, as it is also produced by many natural and man-made sources, including automobile exhaust and industrial emissions. In comparison to most other sources, the exposure to CO from smoking has been described as "insignificant."[4] Still, anti-smoking advocates often assert that CO plays a role in the causation of cardiovascular disease. However, the question of whether exposure to CO from cigarette smoke causes disease in smokers remains unanswered.[5]

VI

Increased attention has been focused on the presence of other constituents in cigarette smoke, some of which may have a toxic effect on or be associated with disease in animals or humans

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at levels and under conditions of exposure greatly different than those encountered by the smoker. Such substances as acetone, ammonia, arsenic, methanol, nitrosamines and phenol -- present in cigarette smoke -- are present everywhere in the environment. They are produced whenever organic matter is burned, whether in industrial emissions, through smoking, or in grilling a steak. The level of exposure to these substances from cigarette smoking is extraordinarily low, and the suggestion that there is something "unique" about the smoker's exposure to these substances is scientifically misleading.

VII

Acetaldehyde is reportedly present in minute quantities in cigarette smoke. Although it is an eye and skin irritant (and sometimes toxic) at high levels of exposure, the available data are considered "inadequate" to establish that exposure to acetaldehyde at any level causes cancer in humans.[6]

VIII

Acetone has been reported to be present in minute quantities in the vapor phase of cigarette smoke. It has been detected in freeze dried foods and dried milk, and is a naturally occurring constituent of human blood and human. Acetone is not considered toxic at low levels of exposure.[7]

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IX

Acrolein has been reported to be present in small quantities in the vapor phase of cigarette smoke. It is present everywhere in the environment as a product of fires, automobile exhaust, and other industrial emissions. Acrolein is also produced by burning foods containing fat, such as grilling a steak. It has been stated that "there is no evidence" to support the claim that acrolein is a human carcinogen.[8]

X

Ammonia is reportedly detectable in minute amounts in cigarette smoke. It occurs naturally as a part of protein metabolism in man and virtually all species of animals. Although ammonia at high concentrations is an irritant, the amount of ammonia in cigarette smoke is so low that one researcher has concluded that its significance to the human smoker is "purely conjectural."[9]

XI

Arsenic is a natural occurring metal that is drawn into growing tobacco (and other plants) from the soil. It is also present in rocks, water, and virtually all living organisms. Although arsenic has sometimes been indicated as a possible carcinogen in animal experiments, its relationship to disease in smokers is considered "speculative."[10]

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XII

Benzene has been reported to be present in small quantities in the vapor phase of cigarette smoke. Although benzene has sometimes been suggested as a possible cause of leukemia, leukemia has not been consistently linked to cigarette smoking in the various statistical studies that form the primary basis for public health criticism of smoking.[11]

XIII

Benzo(a)pyrene (BaP) is sometimes singled out as a human carcinogen because it is a component of the laboratory product "tar," which has been reported to produce tumors under the highly artificial conditions involved in animal skin painting experiments. BaP is formed by the incomplete combustion of organic matter. In addition to cigarette smoke, other sources of BaP in the atmosphere are coal and oil fired power stations, domestic heating, automobile exhaust, industrial emissions, forest fires and volcanic activity. BaP is detectable in fish, meat and vegetables, as well as in drinking water.[12]

XIV

Butane may be present in the vapor phase of cigarette smoke in minute quantities. It occurs in natural gas and is present in the atmosphere as the result of the combustion of gasoline and

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other petroleum products. The inhalation of butane has not been reported to have chronic health effects in humans.[13]

XV

Cadmium is a trace "heavy metal" present in tobacco and in cigarette smoke. The principal sources of cadmium exposure for man are from food, dairy products and drinking water. It has been observed that the data for the claimed carcinogenicity of cadmium in cigarette smoke in humans is "very limited."[14]

XVI

Chromium is drawn into growing tobacco from the soil. As chromium is a naturally-occurring constituent of the earth's crust, it is present virtually everywhere in the environment, in the soil, in water, and in the atmosphere. The most significant sources of chromium intake for most people are through food and water. Although some studies of chromate-industry workers have caused concern about a possible role of chromium exposure in human disease, the level of chromium to which a smoker may be exposed is vastly lower.[15] In fact, some researchers have concluded that none of the chromium in cigarette tobacco is transferred into mainstream smoke.[16]

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XVII

Hydrogen cyanide (HCN) is reportedly present in minute amounts in the vapor phase of cigarette smoke. HCN is also generated by the combustion of carbon materials in air, for example, during home cooking. It is also present in such varied food products as bitter almonds, lima beans, soybeans, apricots and linseed. The level of HCN in cigarette smoke is extremely low, and research indicates that it is rapidly eliminated from the smoker's system.[17]

XVIII

Lead is drawn from the soil into growing tobacco. It is present in the air, soil and water, and all persons are exposed to and ingest small amounts of lead each day. The incremental additional exposure of a smoker to lead is considered to be inconsequential compared to the intake of lead from other sources.[18]

XIX

Methanol is reported to be present in very small qualities in cigarette smoke as a vapor phase component. It is also present in bread, soy sauce and various fruits and vegetables. Although in large concentrations methanol can be a skin and eye irritant, one researcher stated he was unable to find any studies showing the inhalation of methanol in the amounts present in cigarette smoke to be carcinogenic.[19]

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XX

Naphthalene is reportedly present in small quantities both in "tar" and in the vapor phase of cigarette smoke. It is created by the combustion of tobacco and other organic materials. In the home, it is found frequently in air fresheners, moth balls, varnishes and wood preservatives. Naphthalene has no conclusive reported carcinogenic effect, although is sometimes associated with leukemia in animal experiments. Leukemia has not been consistently statistically associated with cigarette smoking in the scientific literature.[20]

XXI

Nickel is drawn from the soil into growing tobacco. The amount of nickel reportedly to be present in tobacco and transferred into cigarette smoke is very small. Researchers have agreed that there is no credible scientific data that nickel as found in cigarette smoke has been shown to cause disease in smokers.[21]

XXII

Cigarette smoke is said to contain nitric oxide, but very little, if any, nitrous oxide or nitrogen oxide.[22] It has been noted that both smokers and non-smokers maintain consistently low levels of nitric oxide in their blood.[23]

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XXIII

Nitrosamines reportedly are detectable in both "tar" and in the vapor phase component of cigarette smoke. Nitrosamines are also found in soil, air, water and food. Under experimental conditions, certain nitrosamine compounds have been noted to produce tumors in laboratory animals. However, even the U.S. Surgeon General has stated that there is "a lack of direct evidence" that the nitrosamines specific to tobacco cause causer in smokers.[24]

XXIV

Phenol is reported to be present in minute quantities in cigarette smoke. It occurs naturally in animal tissues; the consumption of meat has been identified as a primary source of human exposure to phenol. Researchers have stated that phenol is not present in cigarette smoke at high enough concentrations to cause disease in smokers.[25]

XXV

Polonium-210 is a radioactive element that has been reported to be present in trace amounts in tobacco and cigarette smoke. It is also present in the atmosphere and in soil. Researchers have discounted the claimed risk to smokers, noting the extraordinarily minute quantities at which it is present in cigarette smoke.[26]

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XXVI

Toluene is reported to be a constituent of the vapor phase component of cigarette smoke. It is also present in the atmosphere as a result of industrial emissions, automobile exhaust and gasoline evaporation. Although it is an eye and skin irritant at low levels and concentrations, toluene has not been reported to be toxic or to cause chronic disease in humans at those levels.[27]

XXVII

Urethane is reportedly present in cigarette smoke in very small amounts. It is also a natural by-product of fermentation, and is found in wines, distilled spirits, and beer, as well as in fermented food products such as cheese, yogurt and soy sauce. Although urethane has been suggested as a possible animal carcinogen, even the U.S. Surgeon General has stated it is not present in cigarette smoke in sufficient quantities to cause cancer in smokers.[28]

XXVIII

Vinyl chloride has been reported to be present in minute amounts in the vapor phase of cigarette smoke. It is also present in various food products such as honey, butter and ketchup and in some wines. It has been stated that vinyl chloride is present in cigarette smoke at levels too low to be considered carcinogenic.[29]

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